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Isabel Seruca
Universidade Portucalense

Pericles Loucopoulos
University of Manchester Institute of Science and Technology

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Capturing Patterns Within a Business Domain: A Summary of Field Experiences

Isabel Seruca
Departamento de Informática
Universidade Portucalense
iseruca@upt.pt

Pericles Loucopoulos
Departament of Computation
University of Manchester Institute of Science
and Technology - UMIST
pl@co.umist.ac.uk

Abstract

Although the reuse of patterns within business domains has many potential benefits, a lack of a situational method for sorting through the immensity of domain knowledge towards the capture of patterns may constitute a handicap. Realizing the difficulty associated with pattern development due to its empirical and knowledge-intensive nature, we propose a method to aid in the process of capturing and reusing patterns in a business domain. In this paper, we provide an outline description of the first stage of the method dedicated to the capture of patterns. Our approach to pattern development is based on domain analysis principles and is process-oriented, so as to ensure a progressive and increasing understanding of the business domain and the awareness of new opportunities for improving business. We report our experiences in applying the pattern development approach within the Clothing Manufacturing domain in the context of a business process improvement project.

Keywords: Domain analysis, pattern development, business pattern, reuse

Introduction

The origins of patterns are in the work of Alexander within the field of architecture (Alexander et al. 1977; Alexander 1979), and subsequently in the software development community (Gamma et al. 1995; Beck 1997; Buschmann et al. 1996). Recent years however, have seen the emergence of the use of patterns in other domains. The move towards the use of patterns in different domains has included, some genuine attempts to use patterns in the organisational and business domain. This recent trend in business-oriented patterns has had several contributions in (Fowler 1997; Martin et al. 1998; Grosz et al. 1998; Grosz and Rolland 1997; Prekas et al. 1999; Rolland et al. 1998; Kilov 1999; Eriksson and Penker 2000) and explores the idea of developing and reusing patterns to solve recurring business problems.

Many problems that recur when modelling business systems have been solved before. So why solve them all over again? Patterns make it possible to capture and describe these business-modelling problems and their corresponding solutions so that they can be subsequently reused, allowing other practitioners to benefit from the experience of the pattern designers. In this way, reinvention and rework of these solutions are prevented and intellectual effort is saved as well as time and costs.

It is important to realise that these patterns are not "invented"; they are found in existing models that describe real-life business systems. The recognition that knowledge captured by patterns is already present before the patterns themselves are developed has led to the conclusion corroborated independently by several authors (Coad 1992; Fowler 1997) that pattern development essentially consists of the *identification*, *collection* and *codification* of this knowledge, rather than its creation from scratch. A consensus also exists in that the process of discovering patterns is mainly empirical. They are built by observing practice in a domain and by trial-and-error.

We argue that a systematic approach to collecting and analysing business domain knowledge towards pattern development can provide much support for the capture of business patterns. The proposed method is intended to be applicable in the context of Business Process Improvement projects.

The paper is structured as follows: Section 2 presents an overview of the overall PattCaR method, introducing its major concepts and features. In Section 3 we present an outline of the way-of-working for developing patterns and in Section 4 we describe our experiences obtained with the application of the pattern development method in a case study within the Clothing Manufacturing domain. Section 5 concludes with a summary and our directions for future work.

The PattCaR Method

Main Concepts and Features

Our research contribution comprises the Pattern Capture and Reuse (PattCaR) method, which is proposed as a disciplined approach with the overall aim of easing and guiding the capture and reuse of patterns in a business domain.

We use the term domain to denote the *business area*. In other words, such a domain contains not only the applications but it is also constrained by external forces (e.g. economic factors) that motivate the domain (e.g. insurance, banking domain). Accordingly, the patterns that we consider are termed *business patterns*, that is, they are solutions or responses to recurring problems and opportunities that 'design' the business.

Our approach to pattern development can be characterised by two prominent features namely *domain analysis* and *process-oriented view* and we describe next how they overall contribute to our purpose.

Domain Analysis
Domain analysis was introduced by (Neighbors 1980) and refers to the process of analysing a domain for reusability. It can be defined as *'the process by which information used in developing systems in a domain is identified, captured and organised with the purpose of making it reusable when creating new systems'* (Prieto-Diaz 1990). Domain analysis has been extensively studied and applied in the software engineering field where several domain analysis methods have been proposed. Comparative evaluations of the most important methods can be found in (Wartik and Prieto-Diaz 1992; Arango 1994).

Although domain analysis methods are not dedicated to the capture of patterns but rather to the definition of any kind of reusable components, it is recognised that there is an intersection of goals and techniques in pursuing domain analysis and pattern development (Harisson 1997; Coplien 1997). This common ground suggests that our approach can benefit from trends and techniques established in the field of domain analysis. As an overall contribution to PattCaR, domain analysis is seen as a useful paradigm to collecting domain knowledge and to facilitating the understanding of a domain. Additionally, we believe that specific domain analysis techniques (e.g. commonality/variability analysis) can help towards the identification of individual patterns as well as in their classification, organisation and interrelation (e.g. facetted scheme).

Rather than choosing a particular domain analysis method as a starting point, which would restrict the possibilities of being well-suited to the large variety of contextual factors (e.g. business needs, evolving software process, changes in domain knowledge, etc), the option taken here is to base PattCaR on the core domain analysis key activities that are always performed regardless of the method used. These activities are the subject of Section 3. The argument that all domain analysis methods share these core activities despite the differences of emphasis and the specific techniques they employ, can be found in (Prieto-Diaz and Frakes 1992; Arango 1994).

On the other hand, the specific characteristics of patterns as reusable components which we describe in (Seruca 2000a) and term *Capture of Practice*, *Abstraction*, *Organising Principle*, *Value System* and *Presentation* led to the need of customisation of that set of core domain analysis activities.

Process-Oriented View
Our approach to pattern development is dedicated to the capture of patterns for business process improvement. Hence, the main problem areas that may be identified for the development of PattCaR patterns are those related to the redesign or improvement of business processes. The fact that we emphasise a business process view to business modelling is therefore a requirement when engaging in any kind of reengineering activity including incremental improvement. In fact, the very definition of Business Process Reengineering (Hammer and Champy 1993) contains the essence that it is the understanding of business processes that enables businesses relate their strategic objectives with their day-to-day functioning.

The business process model is the focal point around which a business is conducted or around which business operations are improved. Therefore, the emphasis of our approach is on identifying business processes that are important for a successful transformation of the businesses operating in the domain of interest into competitive players. This type of problem area is related

with the ways of organising the various day-to-day activities of the businesses and requires an examination of the organisational, operational aspects and their participants. We use well-known process classification frameworks (Porter 1985; Malone et al. 1999) to aid in process identification and modelling.

An Overview of PattCaR

The method encompasses two main procedures as depicted in Figure 1: the *pattern collection* procedure and the *pattern reuse* procedure. These will accomplish respectively the two activities that are classically associated with the reuse process (Karlsson 1996): the one that deals with the process of defining reusable components (known as '*Design for Reuse*') and the one that is concerned with the effective usage of the reusable components (known as '*Design by Reuse*').

Since this paper deals with the development of patterns, we naturally concentrate on the activity of 'design for reuse'. The underlying ideas of this procedure are *"How one should go about doing the empirical observation in a business domain?"* and *"Good patterns may be obtained if the domain knowledge is captured in this way…".* In other words, the method should not only facilitate the empirical observations and abstractions that the capture of patterns require but also help to elicit good patterns.

In the context of this work, the notion of 'good patterns' is related to the following points. In terms of enterprise development, Coplien argues that *" … patterns should help us not only to understand existing organisations but also to help us build new ones"* (Coplien 1995a; Coplien 1995b). A further characteristic of the use of patterns is in their *generative* nature. That is, a good set of patterns, in our case enterprise and domain patterns, should help to indirectly generate the right processes for understanding and developing organisations.
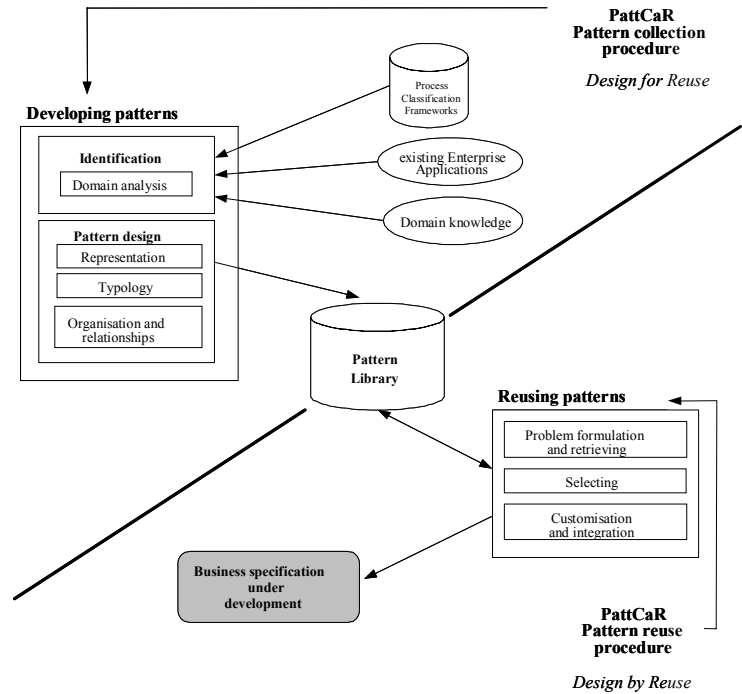
Figure 1. The PattCaR Method: Overview

The PattCaR Pattern Collection Procedure: Way-of-Working

As its name suggests, the key objective of the pattern collection procedure is to capture patterns in a business domain. It provides guidance on the process of observing and studying existing enterprise applications in the domain towards the eliciting of patterns, their subsequent definition according to a pre-determined pattern template and typology, and finally their organisation in a pattern library according to different classification schemes.

The PattCaR pattern collection procedure defines six basic activities shown in Figure 2 together with the respective deliverables. The depicted activities are the result of a customisation of the domain analysis core activities identified in several surveys of domain analysis methods (Wartik and Prieto-Diaz, 1992; Arango, 1994), with the aim of addressing the specific characteristics of patterns. In order to tackle the demands of pattern development the process devised is iterative (from Step 3 onwards) and involves domain experts and method experts (analysts) in some co-operation.

The initial set of domain analysis core activities from which PattCaR activities were derived comprises the following: *(1) Acquire domain information*, *(2) Analyse and classify domain entities*, *(3) Structure domain knowledge* and *(4) Generate reusable structures*. The customisation was done to address the specific characteristics of patterns as reusable components: *(i) Capture of practice*, *(ii) Abstraction*, *(iii) Organising principle*, *(iv) Value system* and *(v) Presentation*. The rationale for the customisation is described in (Seruca 2000a).
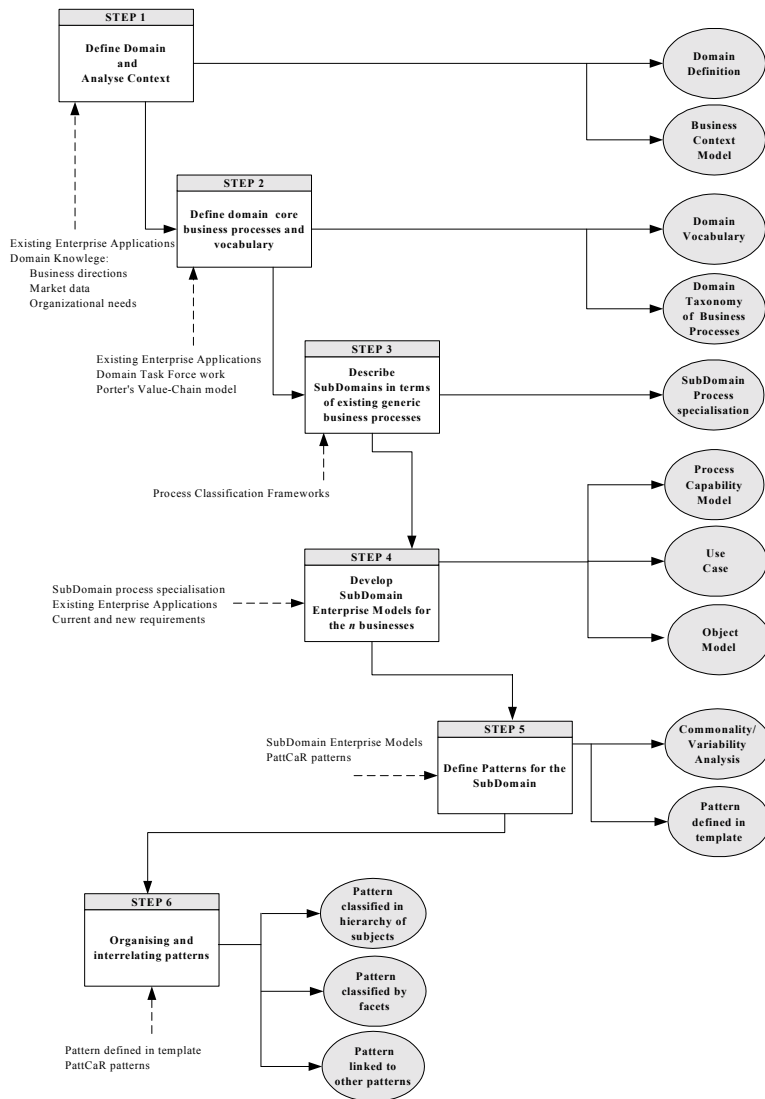
Figure 2. The PattCaR Method: Overview

Figure 2 gives a synoptic and diagrammatic summary of the 6 steps involved, the relationships between these steps and the products derived from each step. Limitations in space constrained us in giving a detailed description of each step and tasks involved, which can be found in (Seruca 2000b).

Experiences Using PattCaR

The Case Study

Clothing manufacturing was the target domain used for capturing patterns. The study of the domain was done in collaboration with the SisConsult consulting firm (www.sisconsult.com) and seven of their clients. The study was performed in the context of a major business process improvement project conducted by the consulting firm, involving seven small and medium-sized Portuguese clothing manufacturing enterprises, aimed at describing, evaluating and redesigning their business processes and concepts. Pattern development aimed to consolidate the knowledge and experience gained from the study, by offering solutions that have already been tried and tested.

The whole application of the PattCaR pattern collection procedure in the case study is described in (Seruca 2000c). Due to space limitations we present a brief description of the way pattern development was conducted.

The enterprise applications in the domain of interest were used as the main source of experience from which candidate patterns were collected. On one hand, these enterprise applications were used as the design cases for identifying the problems of interest and on the other, they provided the enterprise models responding to these problems. A study of these applications led to the identification of recurrent enterprise models that were matched to specific problems in the selected domain.

The process-oriented approach started by breaking a domain into its main business functions, proceeded with describing the corresponding business processes taking a horizontal perspective, and ended with making comparisons on the way a selected process was modelled in the multiple enterprises of the same domain.

A complementary feature was the generalisation of the various solutions proposed for each problem and the creation of one (or possibly more) abstract models representing the exemplar solution discovered. This task was accomplished by a *commonality and variability analysis* (Coplien et al. 1998) of the available design elements.

In terms of semantics, PattCaR patterns are *encapsulated conceptual models*. The basic element of each pattern is an enterprise model that is complemented by knowledge aimed to facilitate its reuse: the problem that the pattern is solving, the applicability conditions of the pattern and so forth. The fact that patterns are built upon the foundations of the conceptual modelling paradigm is a natural consequence: as the basic elements of organisational design are models, the reusable elements of design will necessarily contain at least a modelling part.

Lessons Learned

Based on our experience in applying the PattCaR pattern collection procedure within the Clothing Manufacturing domain we have formulated the following conclusions. Some of these were used to make adjustments in the specification of the method.

Domain Taxonomy of business processes. We found that this was essential for the identification of the main functional areas of the domain and for determining the core business processes early on. The taxonomy was used subsequently as a "road-map" for the identification of problems within the domain of interest. In the revision of the taxonomy the participation of the domain experts was determinant, as they provided the necessary feedback. More often than not, explanation of an issue raised further questions and uncovered new terminology providing further material for discussion.

Need for the definition of Sub-domains. We found that, in practice, for the purpose of discovering patterns and in order to tackle the complexity of large domains, a domain had to be treated as the individual analysis of sub-domains. We also acknowledged that by finding smaller, more specialized parts of the domain, we had a better chance of locating stakeholders who were experts in that part of the domain. Sub-domains could be chosen among the macro business processes identified in the taxonomy. Each sub-domain (e.g. Sales) could in turn be decomposed in several processes. Each of these processes (e.g. Order Negotiation) was then analysed for identifying reuse potential.

Definition of Use Cases and their connection with patterns. The patterns captured were typically patterns that captured the processing policy for a business event or use case. We found that, businesses respond to events (e.g. 'A customer requests to negotiate an order with the clothing manufacturing trading manager'). We therefore used the business event as a unit of work to be analysed for patterns capture. The use cases considered in PattCaR are therefore event-driven. Instead of making arbitrary choices as to what constitutes a use case, we based our partitions on something tangible and recognizable: a business event. We found it was relatively easy to locate one or more stakeholders who were expert in these units of business work and that could describe the work precisely and in detail. They could describe both the normal cases where everything goes according to plan and the exceptional cases.

Commonality/Variability Analysis and Synthesis. We found this type of analysis essential in successful pattern discovery as it helps in identifying the common features of similar models and the elements distinguishing them from other models. Apart from being able to recognise the commonalities among the candidate elements (i.e. the invariant properties), in pattern identification we must also be able to specify the discriminant criteria. We thus want to be able to distinguish candidate recurrent concepts that can be the basis of a pattern from those who cannot. In doing this we are essentially identifying the characteristic features of a problem and therefore what differentiates it from other similar problems. It follows that a key point in pattern identification is to find what is unique in a particular type of situation. Through this activity we can also discover the invariant relationships that are needed in establishing a repeatable solution.

An example of this kind of activity is shown in Table 1, which shows the variability analysis done for the Order Negotiation process in the seven enterprise cases. The results are presented in a hierarchical form, where large-grain areas of variability have been decomposed into finer-grain areas of variability. For example, regarding the Order Negotiation problem, two main accepted business practices were identified (summarised in points 3.1 and 3.2 and further detailed in their respective decompositions) which are dictated by the type of the clothing manufacturing enterprise. As each of these business practices applied in at least or more than three enterprise settings, it seemed reasonable that they could be encapsulated in two different patterns. One of these is illustrated in Figure 3.

Number of enterprises considered in the chosen domain: experience count. We think that in order to successfully find and exploit commonalities and variabilities in a domain, a considerable number of different cases or enterprises has to be analysed. These different studies or analyses can serve as an important experience base which we feel is required to give credit to the domain patterns captured.

Role of domain experts. Pattern development did not require an extensive presence of domain experts. The role of domain experts consisted mostly in evaluating the material available from the various enterprise cases and the patterns derived from this material. The pattern development process was therefore co-operative and took two complementary forms: that of workshops or interview sessions with domain experts and that of working from distance through documentation exchange. We tried as far as possible to use the analytical expertise of the domain experts to help to explain hard-to-understand concepts, rather than just regurgitate details readily found in domain documentation.

Table 1. Results of Variability Analysis for the Order Negotiation Sub-Process

Aspect	Number of occurrences	Priority
1. Type of clothing manufacturing enterprise according to business activity		
1.1 Own Brand enterprises (OBE)	4 cases	High
1.2 Enterprises without brand (EWB)	3 cases	High
2. Type of customer		
2.1 Customer internal market	OBE	
2.2 Customer external market	OBE/EWB	
2.3 Agent	EWB	
3. Order Negotiation		
3.1 Order negotiation for Own Brand Enterprises	4 cases	High
3.1.1 Get Customer Request		
3.1.2 Evaluate Customer Credit	3 cases	High
3.1.3 Negotiate Order conditions	2 cases	Low
3.2 Order Negotiation for Enterprises without Brand		
3.2.1 Validate Customer Request		
3.2.2 Ask for Product Specification		
3.2.3 Ask for Product Sample Making		
3.2.4 Prepare Budget for Customer Request		
3.2.5 Prepare Proposal		
3.2.6 Negotiate Proposal		
3.3 Control Customer Order payments as negotiated		

Conclusion

In this paper, we presented an outline of the PattCaR pattern development approach, which aims to provide assistance in the elicitation and construction of patterns in a business domain. While we do not argue that the method is a substitute for insight or creativity in pattern development, we do argue that the method promotes a focused approach on the key issues of: (a) driving the observation of practice in a business domain, (b) the creation of domain models to accommodate the knowledge and experience acquired, and (c) in the study and analysis of these domain models towards the discovery of business patterns.

We believe that the domain-independent pattern development method provides the generality of description that is necessary to enable it to be used in other domains. The patterns captured within a specific domain should have the potential to increase understandability, the dissemination of best practices and promote the reuse of business and organisational knowledge.

A complementary feature envisaged for the PattCaR method is the pattern reuse procedure, aiming to provide guidance on how the captured patterns can be effectively reused. We are currently further elaborating on the specification and testing of this procedure with the aim of providing a full methodology for the capture and reuse of patterns in a business domain.
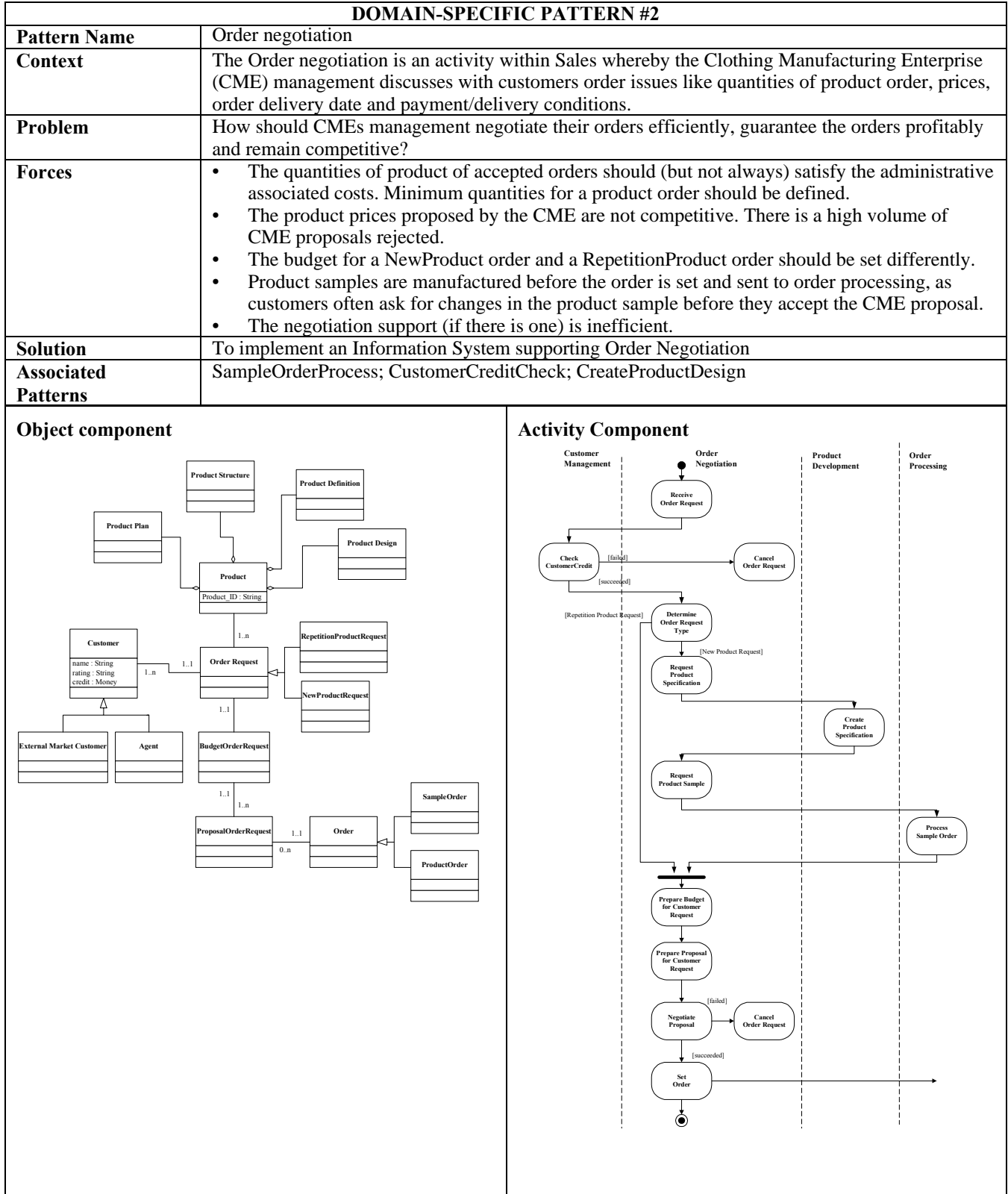
DOMAIN-SPECIFIC PATTERN #2	
Pattern Name	Order negotiation
Context	The Order negotiation is an activity within Sales whereby the Clothing Manufacturing Enterprise (CME) management discusses with customers order issues like quantities of product order, prices, order delivery date and payment/delivery conditions.
Problem	How should CMEs management negotiate their orders efficiently, guarantee the orders profitably and remain competitive?
Forces	• The quantities of product of accepted orders should (but not always) satisfy the administrative associated costs. Minimum quantities for a product order should be defined. • The product prices proposed by the CME are not competitive. There is a high volume of CME proposals rejected. • The budget for a NewProduct order and a RepetitionProduct order should be set differently. • Product samples are manufactured before the order is set and sent to order processing, as customers often ask for changes in the product sample before they accept the CME proposal. • The negotiation support (if there is one) is inefficient.
Solution	To implement an Information System supporting Order Negotiation
Associated Patterns	SampleOrderProcess; CustomerCreditCheck; CreateProductDesign

Object component

Activity Component

Figure 3. A Domain-Specific Pattern for CMEs Without Brand Order Negotiation

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